[SUPPLEMENT]

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Translation of Aménagement des Forêts, ...

TRANSLATION OF AMÉNAGEMENT DES FORETS PAR M. PUTON.

TRANSLATOR'S PREFACE.

THE purpose and scope of this work is sufficiently indicated by the notice prefixed to the second edition of the original.

"Two subjects," says the author, "must be known in order to undertake, efficiently, the management of a forest estate; 1st, the *cultivation* of the species of which the forest growth is composed; 2nd, the *preparation of plans for working*, and the mechanism of such plans."

These two branches of forest knowledge,—sylviculture and "aménagement," or the art of drawing up working plans,—are intimately connected: one helps and illustrates the other, but each has its own distinct line.

This work presupposes that the student has studied the subject of sylviculture as described in special works devoted to it.

The object at present is not to teach or even to indicate the different processes which are necessary to be gone through in order to draw up a scheme of working. This procedure is described in a treatise prepared by M. Nanquette, the learned Director of the Forest School at Nancy.

Still less does the author attempt to state theories or discuss doctrines. These are special works which deal with such matters, among which may be mentioned the "Etudes sur l'Aménagement des Forêts" by M. Tassy.

The object, thus strictly limited, of the present work is to indicate the mechanism of the methods usually employed in drawing up schemes of working, to explain, in short, what an "aménagement" or scheme for working is; and how the accounts of the yield and working of a forest are made out on the basis of the working scheme.

This is a matter of practical administration, and it is important to carry into the working of forests those ideas of accounting for everything, and showing the effect in profit and loss, in stock, and pecuniary yield, which are just as necessary in the case of public estates as they are in the management of private property.

Elementary books ought to be limited to this practical view of things rather than attempt a survey of scientific principles too often incomplete in themselves.

PART I.

General Notions of Forest Economy.

Chapter I.—Of the Exploitation of Forests Generally.

Capital of exploitation, or growing stock.—In order to work (or derive the appropriate products from) a given estate stocked with forest, just as in the case of land bearing crops, or with grazing ground or meadow land, there must be a *stock* which economists speak of as the *capital* or *material of exploitation*. In agriculture, this capital consists of the farm buildings, the seed-grains, the cattle, and the agricultural implements: part of this consists of fixtures, and is immoveable; part is moveable. In the case of forests, the whole stock is immoveable. If we take the case of a coppice to be mature for cutting at 20 years of age, the stock is represented by a growth of trees in a graduated scale extending for 1—20 years in age. In the case of high forest, mature at say 120 years, it is a growing stock in a scale of ages from 1—120 years.

This statement at once brings to notice the difference which exists between forest property and agricultural property. In agriculture if the proprietor manages badly, and is obliged to wind up his estate, he cannot ordinarily dispose of his farm buildings without parting with the land also. By themselves, the buildings have no value. In the case of forest property, on the contrary, the owner would be able to convert into money the entire timber growth, apart from the land, and the land so denuded would remain, though unable to make any return in timber, till such time had elapsed as was necessary for nature to reproduce a new growth of trees ready to be felled.

This leads me to remark how necessary it is for a public administration to watch over the due conservation of the stock in forest estates, whether they belong to the State, or to communities, or to public institutions, since these bodies, as proprietors, are not like individuals who may do what they like with their own, but are "legal persons" (*êtres moraux*) having a perpetual existence in the eyes of the law, and, therefore, the individuals composing them at any given moment cannot deal with the estate as if it were their property. They are only in fact the enjoyers of the usufruct, and are bound to hand down to their successors the estate itself, with its stock or capital, unimpaired.

The public interest would suffer unreasonably if for any cause, even one of great present emergency, the capital were seriously attacked, since we cannot restore full grown trees, as we can put up new and complete buildings even with the most liberal outlay of money. Time alone—and that in most cases a very long time—can restore the forest capital once destroyed.

Another point of difference may also be noted. In agriculture a proprietor who is in want of money can sell his cattle, his ploughs or his carts. For ordinarily these implements find ready purchasers in other agriculturists, who can apply them to working their property—they are in fact transferred to another estate; that is all. The individual may suffer, but society is not affected. A forest proprietor, on the contrary, is always under the temptation to sell a portion of the trees that constitute the scale of ages necessary as a capital for a proper exploitation: * if he does so a double misfortune results. In the first place, the material is not transferred to another estate, there to be used productively; it is consumed and serves for no further productive purpose; there is then a positive diminution of the timber-producing agencies in the country. In the second place, a large additional stock of fire-wood or timber being thrown into the market, the supply may exceed the demand. The production may not stand in a proper relation to the consumption, and the price consequently falls; the public interest then suffers, since the neighbouring forest proprietors cannot obtain a remunerative price for *their* wood. Trades which consume wood are, for the moment, supplied cheaply and abundantly, but have to pay dear for this later when wood becomes scarce; and, lastly a precious material has been made cheap and squandered, there being no means of replacing it, since time alone, not human effort, can produce it.

There is no need of agricultural science to be aware that in all countries agriculture may be conducted on the large or on the small scale. One man works with a small plot of land with simple hand implements, and manure bought retail in the market. The other works with extensive ranges of buildings, with steam-machinery and a considerable extent of land. It is possible also to classify forest cultivation into major and minor.

You have HIGH FOREST or timber cultivation where the trees are reproduced from seed; and the COPPICE, where the reproduction is by shoots from the stool or root-stock.

This division corresponds to that of forests working with an extensive capital of exploitation, and working with a limited capital.

Trees that are to be reproduced by seed do not usually produce good seed, till they are of considerable age; and thus to work on the basis of a high forest you must have a long scale of ages, and consequently a large area of land and a great mass of growing material.

* The author remarks that in French the term "*exploitation*" is sometimes used to mean merely the work of cutting trees, logging or sawing them up, and clearing them out of the forest. He is using the word here (and mostly elsewhere) in the economic sense (in which we follow him) of getting the produce of interest-value out of anything,—working a commercial, industrial (or forest) enterprise, so as to obtain the desired result in yield or proceeds.

When you work by coppice, the shoots grow up in a comparatively short time, and you have a shorter scale of ages, and can work with a smaller area.

Let us take as an illustration the case of two estates, each of 300 acres, treated one as coppice, with a rotation of 20 years, the other as high forest at 120 years.

I. *For High Forest.*—Let us suppose that an acre of forest produces 8,400 cubic feet* at the age of 120 years. The capital will be formed by a series (total 300 acres) of compartments or divisions of the area occupied: severally, by trees of ages from 1—120 years, and the value of solid wood in each, will follow a scale of 0 in the youngest to 8,400 cubic feet in the oldest. The mean or average will then roughly be 4,200 cubic feet. We can then represent the standing stock or capital as $300 \times 4,200 = 1,260,000$ cubic feet.

II. *For Coppice.*—Supposing one acre of coppice at 20 years to yield 700 cubic feet. The capital similarly constituted as above, and with a rough average of the contents, will be $300 \times 350 = 105,000$ cubic feet.

A timber producer, who wished to work his estate of 300 acres by high forest, must then have a constituted capital of 1,260,000 cubic feet of growing timber, while one who was content to work by coppice, could exploit the same area with a producing stock of twelve times less.

In order then to work for high forest, the proprietor must be very rich; and, speaking generally, it is only the State or great public institutions or commercial bodies that are able to afford the large capital necessary; and, further it is only such bodies that are rich enough to be beyond the temptation of from time to time making inroads on the capital, or that are rich enough to wait while the capital is being built up by process of time.

Speaking generally, we may say that private forest property can best be worked on the coppice-plan, and that it is only States and institutions that are imperishable that can afford to work high forest.

There are other reasons also leading to the same conclusion. Agricultural products are always the same whether they come from cultivation on the large or on the small scale. They always consist of grain, fodder, or cattle. In forest property it is otherwise. Forests worked on the "petite culture," or as coppice, yield only small wood, wood for charcoal, and faggots. It is high forests alone that can give planks, railway sleepers, and timber for purposes of construction. Now both the one class of produce and the other are equally necessary to the country; and as there are not, as a general rule, proprietors rich enough to have, and above all to *maintain permanently*, high forests yielding timber of large size, the State and public institutions are bound in the interest of the public welfare to keep up forest estates capable of supplying the community with this most indispensable material.

* That is feet of solid wood, not merely wood in stack. This solid measure is spoken of in France as "*en grume*." The measure applied to firewood in stack when the external measure represents a block partly of space, partly of wood, is the *stère*.

Quantity of Material produced.—The sum total of valuable products (and consequently the material wealth of the country) increases, notably by means of forest (high forest) cultivation on the large scale. Let us return once more to the two examples already given, and which we shall keep to in order that our reasoning may be more readily followed.*

We assume that under coppice treatment an acre would produce 700 cubic feet at 20 years of age; that is about 35 $\left(\frac{700}{20} = 35\right)$ cubic feet per acre per annum. Valuing this (roughly for the purposes of the example) at As. 1½ a cubic foot, the product would be annually about Rs. 3-4-6.

But for an estate treated as high forest we should have the annual production per acre:—

$\frac{8400}{120}$ cubic feet = 70 cubic feet. Valuing this larger sized timber at As. 3 a cubic foot, the result would be—

70 cubic feet × As. 3	= Rs.	13	2	0
(Add 15 per cent. thinnings valued as coppice)				
10·5 cubic feet × 1½ As. =	„	0	15	9
Total, ...	„	14	1	9

It has been calculated that if all the forests in France were treated as high forest, then production of wood would be raised by 15,000,000 of cubic metres, and by 290,000,000 francs in value.

But out of 8,000,000 hectares (roughly 20,000,000 acres) of forests which exist in France, about one million hectares (2,500,000 acres) belong to the State, and two millions (5,000,000 acres) to the Communes.

And there are about five million hectares (12,500,000 acres) of private forests nearly all worked as coppice.

Income.—Why is it then, since high forest produces so much more both in mass of timber and in money than coppice, that private proprietors hold so much to coppice and own so little high forest? The reason is very simple. The private proprietor works only for his own immediate advantage: he does not look to the production of a class of wood required by the country at large; nor does he feel himself under any obligation to find labor for the labouring classes, or material to supply the various trades and industries. He only produces wood because he finds forest a safe and paying investment. Let us return to our former example, and make out an account.

Let us take the soil as worth about Rs. 60 an acre.

* The ages selected 20 for coppice and 120 for high forest are chosen arbitrarily for examples only. As a matter of fact the rotation for coppice usually varies from 30 to 35 years according to kind. It takes also 150 to 200 years to produce an oak or a silver fir (*Ab. pectinata*) of large dimensions, and even 300 years for the full growth of the Larch in some parts of the Alps. As a matter of fact therefore, a rotation of 120 years would be too short for high forest. The instances, however, are taken as convenient for example.

Then for coppice :—

(1). Soil 300 acres, @ Rs. 60, ...	Rs.	18,000	0	0
(2). Standing material, 105,000 c. ft., valued at As. 1 for wood in process of growth, ...	„	6,562	8	0
Total, ...	„	24,562	8	0

The annual products are (300 ÷ 20) or 15 acres, yielding 15 × 700 = 10,500 cubic feet of mature coppice, valued at As. 1-9 a cubic foot, or Rs. 1,148-7-0. His yearly income then is in round numbers Rs. 1,140, on a capital valued at Rs. 24,560, or say 4½ per cent.

For high forest we should have the capital :—

Soil as before, ...	Rs.	18,000	0	0
Wood 1,260,000 cubic feet, valued at As. 2 in a growing state, ...	„	1,57,500	0	0
Total, ...	„	1,75,500	0	0

The annual products are—

(1). (300 ÷ 120) or 2½ acres yielding 2½ × 8,400 = 21,000 cubic feet, @ As. 3, ...	„	3,937	8	0
(2). The value of intermediate thinnings calculated at 15 per cent., say 3,150 cubic feet, @ As. 1-9 = ...	„	344	8	6
Total, ...	„	4,282	0	6

His yearly income is thus only about 2½ per cent. on his capital.

It is evident then that high forest, although producing nearly two-and-a-half times as much in material, and four times as much in money as coppice, yields a smaller interest to the proprietor, when we compare the capital respectively engaged in each method of production.

In the present state of society few persons are rich enough to enable them to be content with 2½ per cent. or less on their money; and if any existing proprietor should be so well off, we may be sure that such a state of things will not last beyond two or three generations.

Not to mention possible reverses of fortune, the division of family property is quite enough to upset a calculation in which time and fixity are indispensable conditions.

A private proprietor would also reason as follows :—

The owner of a high forest of 300 acres, with a growing stock of 1,260,000 cubic feet, could easily realize the conditions necessary to work the same on the coppice method: that is to say, he would have 1,260,000 cubic feet — 105,000 or 1,155,000 cubic feet. This stock (rather over the value of ordinary coppice) let us take as worth As. 2; the value will be in round numbers Rs. 1,44,375. So that with this sum in money he could purchase nearly six times as much coppice (since 300 acres coppice was in our example worth Rs. 24,562-8-0).

He could then acquire—

		Rs. A. P.		Rs. A. P.
(1). His old coppice forest of acres worth	300	24,562-8-0,	producing	1,148- 7-0
(2). New coppice forest of acres worth	1,800	1,47,375-0-0	„	6,890-10-0
Total, ..	2,100	1,71,937-8-0		8,039- 1-0

So that instead of 300 acres of high forest, worth Rs. 1,75,500 and bringing in Rs. 4,282-0-6, he would have 2,100 acres coppice worth Rs. 1,71,937-8-0, and bringing in Rs. 8,039-1-0, or seven times more land and nearly double the revenue; and that with security exactly the same, and under the same general method of investment.

What private proprietor then could hesitate to prefer coppice to high forest?

But compare this result so favorable to the individual proprietor, with its results to the country at large. The 2,100 acres of coppice will only yield (at 35 cubic feet per acre) 73,500 cubic feet of wood annually for consumption and use in industry; whereas worked as high forest, the same number of acres would produce (at our already shown rate of 70 cubic feet per acre) 147,000 cubic feet of material of far higher value, not only in money, but by the amount and usefulness of the labour which can be employed on it.

The advantage of the high forest treatment is that it supplies to the country at large, more than twice as much in the elements of employment of labour and industry, and five times more in the elements of utility and exchange. But these are advantages which are of value only to the public, not to the private proprietor, whose only care is to invest his money for his own benefit.

It has followed in France, that the timber forests formerly possessed by the feudal nobility and the Church, which were confiscated at the Revolution, and all the State forests which have since been (from time to time) alienated, have with rare exceptions been diverted from their original treatment, and converted into forests worked "à petit capital," or coppice forests, —the only ones which the means of private owners will permit them to follow.

Let us also bear in mind that the working capital and growing stock of a forest destined to produce timber of large size, if once destroyed, is incapable of speedy reconstitution, unlike that of a farm or that of a manufacturing business. With sufficient money these latter can be restored in a single year. But in a forest, spend what you like, and you must still have a century or more to restore your capital.

It will now be obvious to the reader that the interest of private owners is *against* the conservative treatment and work-

ing necessary to the high forest method, and that private owners are *incapable* of being the continuous producers of timber of large size.

*Position occupied by State Forests.**—The economic requirements of private property just considered have been further confirmed by successive modifications in the law relating to private property.

The ancient law of succession tended to preserve intact, in certain families, large patrimonial estates; but this is now a thing of the past, and all property is equally liable in law to indefinite partition.

The ancient customary law also, while it made timber trees immoveable property, and as it were a part of the soil, saved them from the destruction caused by the creation of usufructs and other temporary modes of enjoying property; nothing now restrains the enjoyment of any kind of property, but the terms of the contract.

The Marine service had in private forests a right of pre-emption, or prior claim to purchase certain timber of large size. This was abolished in 1837, but it had, while it existed, the effect of encouraging the production of timber in State forests for the benefit of future generations.

It is only in the nature of things that such restrictions should disappear before the progress of a democratic society, whose characteristics are a vast expansion of industry and trade.

In France then, as in most modern societies, it is only corporations or bodies, having a legal existence which never terminates, that are rich enough, and long-lived enough, to devote their forests to the production of large timber, which national industry can never dispense with, notwithstanding the increased employment of iron for construction.

But in respect of these institutions there has also been much change.

Under the ancient monarchy there were three classes of legal or moral bodies, having an unlimited right of holding property. They were—the State, the Commune, and the Church. The last has lost, since the revolution, the right of holding property, at least as far as religious communities are concerned. The State and the Commune alone remain. The great commercial and Financial Companies do not come under this category; they are, in fact, much more like associations finding capital and labor, than associations for saving or amassing property, and besides that they are very far from being imperishable.

Centuries ago, an ancient and national legislation subjected the

* The reader will remember that this is a translation from a French work. The reason for the existence of State forests is therefore based on consideration of the law and social condition of France. But it would be easy to give a series of similar considerations justifying the necessity for State Forest in India or any other country.

Communes when they owned forests, to a legal obligation to reserve one-fourth of their forests as timber forest for the benefit of the country. But in recent times the Communes have been treated as a mere embodiment of the local interest, and they have been consequently set free from this obligation. The "fourth in reserve" as understood under the Forest Code of 1827, is simply a measure of foresight and prudence, and even that, can, in many cases, be dispensed with.

If you were to ask, at the present day, a Commune in the Pyrenees to allow one-fourth of their forest to grow up into timber, and not to touch the trees for a century because the people on the north and west stand in need of timber of several centuries' growth, they would laugh at you! Such abnegation of self-interest can hardly be looked for, when the popular mind is so toned as to be able even for a moment, to raise local egotism to the rank of a social principle.

In France then the State alone remains capable of devoting its forests to the production of timber—a material which only the lapse of long years and prudent saving and abstention can produce.

And it is a most imperative duty and a national obligation resting on the Government, to perform its part in this matter.

Suppose, for a moment, that in consequence of a general sale, so often recommended and so often rejected by the public good sense, all the State forests were to pass into private hands.

In order to make it worth while for the new owners to preserve for future use, the wealth accumulated by the long and expensive mode of constituting capital under which the forest has been created, it would be necessary that the price of timber should be raised to a figure which would be portentous.

It has been calculated that in order to make the normal outturn of timber yield a reasonable rate of interest to a private proprietor, the price of a cubic metre of wood ought to be more than 300 francs (about Rs. 4-4-0 a cubic foot standing in the forest). And even then the rate of interest would not be very high, since the calculation of capital value has to be increased in proportion as the selling price of wood rises.

Such a state of things would be impossible; foreign timber would undersell the local product in its own markets; and private proprietors would give up a task so irreconcileable with their interests. The forests of France would then all become coppice, and would, as the experience of the past proves, furnish nothing but firewood, or small wood for industries and petty manufactures. If it were attempted by law to compel people to conserve their timber forests, and yet not to charge more than a fixed maximum price, that would in fact be to put a special tax on them, since they would be obliged to sell relatively cheap what cost them dear; or else it would be necessary to keep all foreign timber out of the market, demanding all sorts of pro-

tective duties and measures of repression, which are opposed to modern ideas of trade and progress.

It is idle to oppose the necessity for State timber forests by referring to imaginary virgin forests in foreign lands, to which it is only necessary for our national capital and labour to flow, in order to bring in a rich return.

No one can assign a definite locality in which these mines of forest wealth are to be found, and the cry of alarm over the scarcity of timber has begun to be heard in America, as it has long been in the Old World.

But even if we suppose that some country still existed so fortunate as to have a good stock of well conserved timber, and to be able to meet our demand for railway sleepers, ship-building, vine props, buildings of all kinds, and the thousand and one requirements of our voracious civilization, is it not likely that the State possessing the monopoly of indispensable produce might be tempted to make us pay too highly for it? Could it not, by levying a prohibitive export duty, impose on France the most disastrous taxes? wage against her that most terrible of wars—the war against industry?

See then to what a pass the loss of the State forests would bring us! If no restraint were put on the timber trade, still our industry and our power of construction would be at the mercy of foreign supplies. With full liberty to import, but with a compulsory price on indigenous timber, our forest owners would have to bear an unjust and unequal tax, and if foreign timber were prohibited, our own would rise to a prohibitive price, and prove a tax both on labor and on the consumer, the effects of which it is impossible to estimate. The State then must possess forests, and must manage them as much as possible on the high forest system.

It is time to remember that the State forests are intended to produce timber far more than money.

The Revolution found France with 6¼ million acres of forest. In 84 years the area has been reduced to 2¼ million.

CHAPTER II.—*Of schemes of working in general.*

Definition.—Too much space perhaps has been devoted to the considerations stated in the last chapter, but it is very important to make it perfectly clear what a great interest the State has in maintaining forest estates with a properly constituted capital or stock.

It is the express object of the State Forest Administration to see that this capital is never trenched upon, while the legitimate produce is made available for use and consumption.

An "aménagement," or formulation of a working scheme, is an operation which aims at facilitating the effecting of this important object.

The necessity for such an operation will at once appear, when it is remembered, that at the outset, in a mass of forest, it is not easy to distinguish the product from the capital stock. Both consist of wood; and the annual yield is really only a part of the capital set free for use by the growth of each year.

An "aménagement" is an operation which has for its object—

(1). *To determine of what the capital stock should consist, or how it should be constituted so as best to meet the wants and promote the interests of the proprietor; and*

(2). *To regulate the nature, the amount, and the relative order and progressive execution of the cuttings of the material, which, leaving the capital stock intact, constitutes the annual production.*

This brief definition requires some explanation to make it fully intelligible. Before giving this it will be necessary to put the reader in possession of certain details.

Ancient methods.—The arrangement of a working scheme is an operation as distinct from forest cultivation, as, in an industrial concern, the conduct of the business is from the manufacturing process; or, as in an agricultural enterprise, the distribution of crops on the area, and the constitution of the farm, is from agricultural labour.

The great difference is, that in industrial enterprises it is impossible to confound the produce with the capital; in agriculture it is sometimes possible; and in forest work it is very easy indeed to do so.

The question which a forest proprietor has to ask himself reduces itself to a problem which is very easily stated. Is your forest to be worked at, say, 120 years of age? Then the portion which you can cut in each year is the annual production, that is to say, the increment of the standing growth (which consists of trees in a scale of ages from 1 year to 120 years). If one could determine exactly what this annual increment came to in cubic feet, the problem would be solved. By cutting this exact quantity, and no more, the capital would certainly be maintained intact.

But we are not yet perfectly acquainted with the laws of vegetation, and the studies that have been made in this intricate subject have not given results of such certainty as to form a perfect basis for practical work.

The earlier methods of *aménagement*, devised by Hartig and by deSalómon were based on the direct solution of the problem. They determined, by calculating the rate of growth, the volume which each of the different parts of the forest could furnish, up to the moment for cutting. The total volume during the rotation of 120 years was added together, and the $\frac{1}{120}$th part of this total volume would form the annual production which might be taken out from those parts of the forest which cultural considerations indicated.

These more or less complicated methods, based on laws of

increment more or less hypothetical, did not afford results which were satisfactory. The question was then shelved; and as the precise yearly increment of the capital stock, that is to say the volume to be cut, could not be determined, they tried to determine the capital itself, or rather to fix a limit of cutting, a calculated quantity such as might make it certain that the capital was not trenched upon.

It will appear presently that this combination limited itself, in the case of coppice, to a simple division of the area into as many cuttings as there were years in the rotation; and in the case of high forest, to large cuttings made to correspond for a certain number of years, with the estimated volume of wood on the ground actually mature for felling. It is to MM. Lorentz and Parade that in France this simplified method is due, and it has been found satisfactory in its results, and not difficult of application. To MM. Tassy and Nanquette is due the extension of the principle, and the development of its practical application.

Material or Capital of Exploitation.—Before entering into detail about the combinations which constitute the different methods of devising plans of working, it is necessary to impress upon the student's mind the manner in which the capital is constituted in forest estates.*

Does the proprietor of 300 acres of forest land wish to produce an equal and permanent annual yield of wood at an age of 120 years? To do so he ought to possess—

2½	acres stocked with trees of	..	1 year,
2½	acres „ „	..	2 years,
2½	acres „ „	..	3 years,

and so forth; so that if he cuts in the present year the 120th compartment of 2½ acres now 120 years old, next year he will cut the 119th, which now is 119 years old, but next year will be 120, and so on.

If then our proprietor has 300 acres, of which the growing stock is in a regular gradation of *age*, and in that *condition of growth* proper to each age, he will have a forest capable of a permanent and uniform annual yield—he will have in short a capital perfectly constituted.

Three elements then enter into the constitution of the forest capital—the condition of growth, the area or superficial content, and the age. It is necessary that the ages should be graduated from 1 to 120 years; that the trees of each age should occupy an equal area, or an area proportional to the difference which exists in the conditions of growth in the estate: in short that

* "Material of exploitation," or capital, are used as synonymous terms, and the student will understand that they do not convey any idea of a *money* capital. The young stock of a forest is the capital destined to produce the yearly outturn, and is only *analogous* to the money capital which produces a yearly income.

he should have a stock of each age having the consistency and the volume conformable to the laws of growth in the given circumstances. For it is necessary that every year the felling should extend over an area equivalent to the one hundred and twentieth part of the forest—over the part that is 120 years old, —and over the part of the entire mass which cannot be determined *à priori*, but which is the annual increment.

It is necessary to enter into some details regarding each of these three elements, in order thoroughly to understand the economic conditions of forest management. We shall simplify the details by assuming that the general conditions of growth are uniform throughout the locality in which the forest is situated. We are thus free from the necessity of proportioning the three elements among themselves.*

With regard to *area*, it is easy to understand that on an estate of which the soil, the climate, and the situation are practically uniform, equal areas will produce equal quantities of wood. A proprietor who in our example should cut one of the compartments of 2½ acres every year, beginning with the oldest, and taking care that it is re-stocked directly it is cut, will have his capital constituted in the best and simplest manner.

It is obvious, therefore, that a considerable area of land is necessary to arrange the proper working of a forest. We must be able to cultivate and rear properly the trees of each class, according to their cultural requirements at each successive period of their life. The wood-producer, who has to work in earnest, and on a large scale, must possess an estate of sufficient size to give a proper allowance of speed to each age-class.

The proprietor of only a clump of trees cannot work it in the sense of *forest*-working. There is indeed a special method of working forests of small extent, the method of "jardinage," or selection-cutting; but even then the order of cutting is based on the supposition that there is a certain capital constituted by trees of every age, occupying respectively their proper proportion of the whole area.

The second element in the constitution of the forest capital is the *age* of the trees. It is an uninterrupted succession of ages from 1 year to 120 years which alone can enable us to keep up an annual outturn of wood 120 years old.

The circumstances of human labor, and the requirements of life, are, on the average, the same every year. The working scheme must, therefore, aim at producing the same amount of material every year. When we say the same amount of mate-

* A certain number of combinations have been devised in order to proportion the elements of the forest capital, the area, to the degree of fertility, the time, to the volume of wood produced. These methods are but little used, and the establishment of 'working circles,' of which we shall speak presently, furnishes a very simple means, and in general is quite sufficient to obviate inconvenience from inequalities in the local conditions of growth.

rial, we mean approximately according to the nature of the produce. The gradation of ages may be considered to be practically attained when it exists within a limit of difference of five or ten years, or possibly more under particular circumstances.

In small forest properties, the working plan may aim at an annual or a biennial outturn, and dispense with the obligation of an *annual* income, which is the general rule in the case of large proprietors like the State or a Commune.

The third element is the condition of growth, or state of vegetation. The vegetation of trees growing together on a given plot of land produces a stock (*peuplement*), the value of which varies with each year according to natural laws, the existence of which is certain.

Unfortunately what these laws are, is very little known from a practical or experimental point of view; and we know little more than the fact that there *are* such laws.

In order that the stock of each age-class should be properly constituted with regard to the entire forest capital, it is necessary that it should have the *density* and the *volume*, or cubic content, which nature assigns to each age under the given conditions of its existence. The *density* has reference to the number of stems on the acre, the *volume* to the number of cubic feet of wood on the acre.

The number of stems per acre of course decreases with the age of the trees; the volume follows an ascending scale, and is on the increase. This we know, although we are not able as yet to formulate numerically the law of this increase.

The number of stems on the acre begins by being very large in the first years of the growth of the stock. A certain number of them are suppressed by the more vigorous, and die out; and the number of stems goes on diminishing as the bulk of the stems goes on increasing.

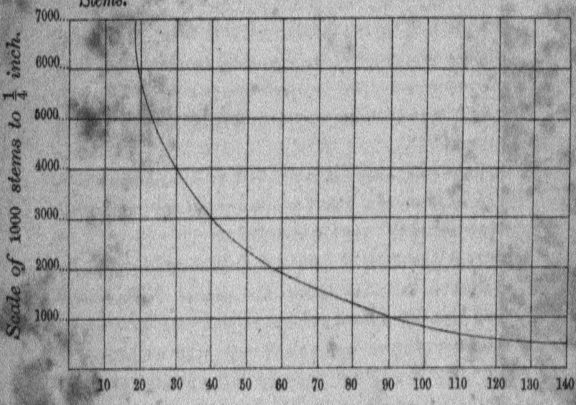
On this fact depends the practice of thinnings * which will be explained in the chapter on high-forest management.

One can easily imagine how valuable would be a knowledge of the actual law of vegetation; the true number of stems per acre for each kind of tree and for each given condition of soil and climate. As it is, our only guide for regulating the number by thinning is the practical experience and the trained eye of the forester. The diagram (*Fig.* 1) will give an idea of the law of decrease in the numbers of stems.

The lower line is divided into equal parts corresponding each to a period of 10 years; on this have been drawn perpendiculars

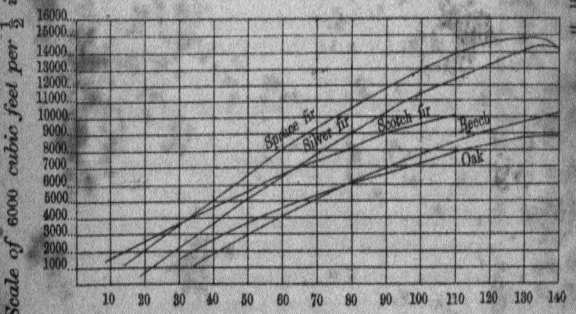
* "*Éclaircies*,"—cuttings not for yield (though of course they may have a certain utility or selling value), but with the primary object of maintaining the law indicated in the text of decreasing number and increasing volume in the stems of the stock.—(Tr.)

Fig.1.



Curve shewing the decrease in number of stems per acre.

Fig.2.



Curve shewing the amount of material per acre for different species at different ages.

SPRUCE

Mc.	Hect.	
1,000 per 1		at 140 Yrs.
= 35,317 cft.	2.47 A.	„ „ „
= 14,300 „	per 1 A.	„ „ „

etc., etc.

So that we have

cft.	
14,300	per A. at 140 Yrs.
„	„ „ „ 116 „
11,440	„ „ „ 86 „
8,800	„ „ „ 63 „
5,720	„ „ „ 44 „
2,860	„ „ „ 23 „

And so for the rest.

C. E. Gabriel, Photo.

C. B. Clifford, Lieut.

Photozincographed at the Office of the Trigonometrical Branch, Survey of India, Dehra Dún, April 1884

representing at the rate of 100 stems to the twentieth of an inch, the number of stems in an acre.*

The curve has been constructed on the *data* of a forest composed of mixed beech and silver fir, and would of course be different for every different species of forest tree cut for different conditions of growth. Hence the diagram is only intended to give an individual illustration of the sort of curve which the descending scale of ages shows in one particular kind of forest.

When a given area of forest is living a normal and regular life, without any disturbing cause to retard vegetation, it ought to contain a volume of wood which is special for each age, and for each kind of tree, and which is different according to climate and situation. This scale of *volumes corresponding to age* constitutes a second law of growth—a law still unknown, the results of it being only known by numerous experiments made on different kinds of trees in different places. The *Fig.* 2 annexed represents an endeavour to construct a curve for five chief kinds of trees on data furnished by tables published in Germany. The lower line gives, as before, ages in periods of ten years; and the perpendiculars show a scale of cubic contents calculated at one-sixth of an inch for 1,000 cubic feet. The resulting curves show the volume per acre for each age-class, but the reader must remember that this is only by way of general illustration, because exact experiments have not yet been made in sufficient number, or under such conclusive conditions as to enable us to lay down positively an absolute curve of increase for any species.

The recognition, however, of the general truth explained by these curves is very useful, not only in regulating the constitution of the forest capital itself, but also in settling important questions of forest economy, such for example as fixing the age at which to fell in order to have the largest quantity of material in comparison with the capital engaged; or determining the value of the capital, &c.

It is sufficient for general purposes roughly to classify the stages, and to describe the state of growth in a compartment by special means: thus we have *seedlings* (jeune semis), *thicket* (fourrés), *saplings* (gaulis), *poles* (perchis), *grown-poles* (haut-perchis), *young timber* (jeune futaie), and *old timber* (futaie). These terms are used in high-forests.

For coppice we use the terms *shoots* (recrus), *young stems* (jeune taillis), *medium-stems* (taillis), and *old stems* (vieux taillis).

These terms are only a convenient means of indicating the

* The plan in the original is given in hectares with the actual scale 0·5 of a *millimetre* = 100 trees or 0·5 of a centimetre to 1,000 trees. Taking the hectare = 2½ acres roughly, the number of trees is 400 per acre, which is near enough for the purposes of the diagram.

general style of growth, and tell us nothing about the volume of the stems, or the number of stems per acre.

The latter condition is roughly indicated in woods (without indicating the quantity) by the addition of the adjectives* *sparse* (clair), *fairly-stocked* (serré), and *fully-stocked* (complet, &c.)

Under all circumstances, however, the state of the stock as regards its growth depends always on one principal element—its age: therefore, when we say that the capital of a forest to be cut at 120 years must consist of a graduated scale of ages from 1 to 120 years, we mean by this formula to express the necessity for a series of compartments, each stocked with the proper age class respectively. This will readily be understood; but it is as well to bring distinctly to notice the real meaning and extent of the formula.

Explanations.—We are now in a position to return to the general definition of an "aménagement" with which we started at the commencement of this chapter, and to study its terms more minutely.

1*stly.*—When I said that the first object of formulating a working-scheme was to "*determine exactly* of what the *capital stock should consist,*" I had no intention of indicating that it had to be estimated either in quantity or in money. That would be useless. The capital must be, during the whole time of working, invariable and constant; that is to say, it must always show the same proportion of the different ages, the same area under each, and the same state of the stock on the area.

Valuation will of course be made of the area and of the volume of wood on it in different parts, in order to regulate the quantity to be removed by felling: but to determine the capital itself, it will be sufficient to have it within defined limits, and then to manage it in such a way that the cuttings will never reduce it.

The combinations involved in a working scheme will be so devised as to allow the annual growth of the wood continually to replace the amount taken out.

2*ndly.*—In undertaking to work a forest, just as in undertaking to work a farm, there must be a definite aim or object in view.

Our object may be to turn out a particular class of produce for the market, say vine-props, hop-poles, planks, wood for carpentry, or perhaps only wood for charcoal, or the proprietor may be indifferent as to the kind or form of produce, as long as it brings him in the largest possible return in money. It may be, that looking to the interests of the consumer alone, his object is to get the greatest outturn of wood of all sorts, or to get that form of timber which is most in demand for commerce.

* See Bagneris' Manuel de Sylviculture, p. 5.

These different objects afford as many different bases for fixing the age of "exploitability."*

They indicate as many different ages at which the yearly cutting of a forest may be fixed.

I shall not enter into the details of the manner in which the age of cutting is determined according to any particular object in view; that would necessitate my travelling beyond the scope and purpose of this book; but it is easy to understand that all enquiries as to the age of exploitability will always end in fixing the age to which the *rotation* of the forest is adapted.†

Now the importance and the value of the forest capital will always depend on the age at which the trees are to be considered mature and felled.

If the felling age is 30 years, the capital will consist of compartments stocked with ages from 1 to 30 years. If the rotation is only twenty years, it will be made up of ages from 1 to 20 years.

The words "to determine the constitution of the capital" in our definition, necessarily include the enquiries as to the age of exploitability to be adopted, and the fixing of the most advantageous length of the rotation. This is, indeed, the first thing to be done in determining the requisite constitution of the capital.‡

3rdly.—It will also be apparent that the definition should include a preliminary matter to be settled before seeking to determine the constitution of the capital: namely, the question, what sort of system the forest is to be worked on? Is it for high forest or for coppice? And in either case, what sort of high forest, whether to work on the natural method, or by selection; and what sort of coppice, whether "simple" or "stored," *i.e.*, with reserved standard trees left to grow to timber size?

It will be observed that, to a great extent, the system of reproduction and the treatment are determined for the proprietor by the nature of the trees of which his forest consists, and by the circumstances in which he is placed.

When it is possible to make a choice among a number of

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* This term indicates the age at which the trees may be cut in order to satisfy a given purpose of the Proprietor—(*Author*).

An oak coppice may be "exploitable" at the age when the bark is most in quantity, or richest in tannin if the object of working is the bark trade; or it may be the age at which the soundest timber in the largest quantity is given if the object is timber for ship-building—(Tr.)

† Rotation (*revolution*) is the period in which the working (yearly-cutting) has gone over the entire extent of the forest, and comes back again to the point at which it began. There may be a rotation fixed for a period which does not correspond to the age at which it is intended to cut (as the age of maturity for the purpose in view) But such a rotation is only a "transitory" or "preparatory" rotation, and is applied when certain operations are required progressively over the forest during a period of preparation, before the regular rotation can begin.

‡ See M. Nanquette's "Cours d'Aménagement," Ch. IV., for the procedure which is necessary to determine the age at which forests are exploitable.

different rotations, the proprietor must choose, and he will then have a capital of exploitation corresponding to the one selected. It is so at any rate in the majority of cases; because one cannot change in a day the treatment of a forest as one can the *regime* of a workshop.

The long process of forest transformation, which we shall study in our chapter on "Conversions," can only be undertaken by proprietors exceptionally situated, such as the State and the Commune. Even in these cases, the determination of the style of management is rather a choice to be made than an operation to be effected. The general term "determine the capital of exploitation" comprehends all the different cases, since the various systems and methods of treatment are each characterized distinctively by the peculiar capital proper to each —a capital on a large scale for high forest and much smaller for coppice.

The operation of laying down a "working-plan," *i.e.*, of determining the capital of exploitation, carries with it the choice of the method of treatment as it carries with it the choice of a length of rotation.

4*thly*.—The choice of the age of exploitability is intimately connected with the class of proprietor who works the forest. A private person does not care what the nature of the consumption of the public is, except so far as it produces a favourable market for his produce. A Commune, and still more so the State, represent far more the interest of the classes who consume wood. The phrase in the definition which alludes to the advantage or *requirements of the proprietor*, is intended to include every possible case.

5*thly*.—The definition also states two objects as aimed at by the process of laying down a working-plan—the determination of the capital of exploitation and the regulation of the cuttings which indicate the amount of the annual production. We shall always find this double object realized in practice by the preparation of a general plan of working, and of a special detail as to the order of the cuttings. The one tends to conform the forest to a style of growth and condition which fits it for a certain purpose. This purpose is as fixed and unalterable as it is in the nature of human affairs to be; the other regulates in a special manner the cuttings to be made during a short period of years. Here, this point is only indicated, as it can better be more fully explained at a later stage.

6*thly*.—The regulation of the working-plan is, in reality, only the application of certain cultural rules to produce a given desired result.

Without following such laws, there can be no good scheme of working, any more than the best distribution of lands in a farm between different crops and the best arranged farm

buildings, will produce a satisfactory return, without reference to agricultural rules prescribed by the nature of the soil and the kind of crops cultivated.

The definition then indicates the natural alliance between the rules of sylviculture and the progress of the exploitation, when it directs the *aménagiste* to regulate the "nature, relative order, and progressive execution of the cuttings." It thus binds him down to the strict observation of cultural principles, of the rules for locating cuttings, and of the laws of vegetable physiology.

The reader will, I am sure, pardon this lengthy paraphrase of the definition: but it is necessary to make it as explicit as possible.

In a book in which only a few pages can be devoted to the theory of the subject, the elementary notions which are necessary to render intelligible what follows of practical information, can only find a place when grouped around the preliminary definitions with which the study of the subject commences.*

Utility of an Aménagement.—Certain forest proprietors have contended that for private forests the advantage of a regular working scheme is illusory, because such a scheme is likely to be upset by the inevitable process of division of private estates. [This alludes to the French law of succession and division of estates among the heirs—Tr.] The objectors have in this case confused the usefulness in the abstract of an aménagement, with the question of whether the scheme is likely to be observed for long. No human undertaking can free itself from the chances of the future or from accidents which may occur in its progress. And the proprietor who provides a working-plan for his forest is just as much subject to this law, as one who starts a manufactory or a trading company.

It is also possible that even the working-plan of a State or Communal forest may be upset by circumstances.

But the utility of such a scheme in itself is quite another matter. It is because of the facility that it gives for the execution of forest operations advantageously and without loss of time, and because of the regularity and method which it introduces into the working, that the laying down of a working-plan impresses the forest with the character of a well managed estate, and consequently increases its value; just as in agriculture a well regulated, and well arranged farm, will always have for an equal area, a greater value, than an estate badly directed, and ill cared for.

Are there not also many circumstances under which a regular

* It may be permitted us to remark that the definition adopted in the text thus is made to fall in with the otherwise much more concise definition in the "*Cours d'Amenagement*" which runs as follows: "[Aménagement is] an operation which for one or several rotations regulates the mode of cultivating and of working a forest to the best advantage for its proprietor, and for the consumer." In a work dealing with the management of public forests, there was no occasion to speak of the capital of exploitation because there can be no good administration or no efficient management, without the existence of a capital account, and consequently of the capital which is accounted for.

plan must be followed, or may be required by law? The various forms on which a mere *usufruct* is allowed by the law, all require it, because such a usufruct legally requires that the "substance of the estate should be intact."*

It is obvious that if the products only have been taken on a regular plan of working, it is easy to establish by proof that the legal conditions of enjoyment have been fulfilled, and thus much ruinous litigation may be avoided. In the case of a liquidation, or rendering an account on termination of a usufruct, if the estate has been managed on a regular plan, it will avoid much difficulty, and many disputes, to be able to show what was capital and what was produce, and that the former has been left intact. Had this not been ignored, how many powerful families would have still remained united.

Condition of the forest.—We have already seen that a forest fit for working must show a certain gradation of ages, and a certain uniform state of growth. A theoretically correct condition of forest in this respect is called a "normal forest."†

A perfectly normal forest rarely or never exists in nature, but such a condition must be kept in mind, not as an object to be attained (which is probably impossible), but as a basis or standard of comparison for every combination which enters in to the working scheme.

The capital of exploitation or standing crop is constituted when the three elements—area occupied by the different growths, age, and a certain state of vegetation or rate of growth—exist all of them together in a manner sufficient for working the forest at all. It is then possible to find a forest in which the capital is constituted as far as the gradation of ages is concerned, but which does not contain a sufficient area occupied by each, or a sufficient volume of each. There may be also different cases in respect of rate of growth,—the differences being almost infinite when the vast variety of climate, &c., is considered. But practically all cases are reduced to the three following which will be the basis of our study:—

(1). *The standing crop is just large enough for the chosen rotation.*
(2). *Or it is excessive.*
(3). *Or it is insufficient.*

The first case we call "regular," because it approximates to the theoretical condition of a normal forest already described, as far as circumstances allow. The second is unfortunately rare. The demands on the forest are too incessant to make it likely often to occur. But it may occur when the proprietor wishes to shorten the term hitherto contemplated for the

* Code Civil, Section 578, *et seq.*

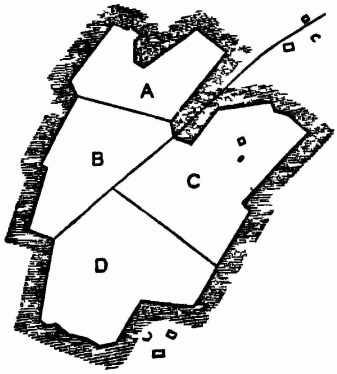
† The normal forest is one that presents a gradual succession of ages, and a growing stock of each age, growing under equal circumstances, as regards area occupied by each, soil, climate and exposure, such as will result from a regular process of growing during the entire rotation.

maturity of his forest. The third is the commonest, and is one which requires the skill and care of the forester.

The reader will remember that in actual practice we have always to deal with forests more or less irregular.

Formation of compartments (*Parcellaire*).—The first difficulty is, to obtain a practical knowledge of the manner in which the forest for which we wish to lay down a working-plan is constituted:—We have to find out what it really contains. It will be readily understood that in a forest of any size it is not possible to obtain at first sight, and by a general inspection of the whole, a clear and sufficiently exact idea of its resources. We have then to begin with an analysis and an inventory of its contents. But here we are not dealing with an inventory of the number of trees or of the total number of cubic feet. It is something much more simple than that. We have to go over the whole ground, surveying the different divisions indicated by lines, and thus marking out all the different *local areas which consist of groups homogeneous in age, in kind of tree, and in conditions of growth, and which are accordingly susceptible of the same treatment.* These local areas or bits of forest are called *compartments*, and impress themselves readily on the memory, so that having divided the whole area in this way we are able to seize the entire aspect of the forest and grasp its resources as a whole. It is necessary also to separate the portions which, from their different aspect, or different species of tree, will require, pretty permanently, a special method for the cultivation of the growth on them. We shall thus discover by the combined work of memory and inspection, if the forest capital is constituted, that is to say, if the forest already presents a sufficient capital to permit of a regular exploitation based on the term of years adopted for the rotation.

Forest of Ancourt.



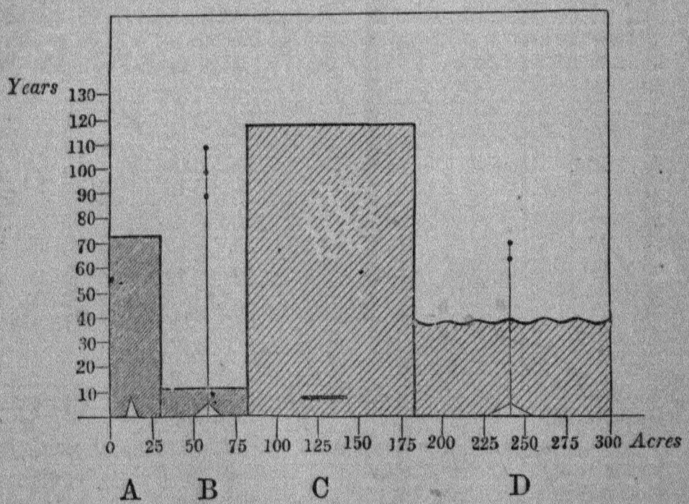
Each compartment is carefully described in a register to which reference can always be made.

When, however, the forest is large, and the number of compartments considerable, the mind begins to get confused, and it is desirable to clear up matters by some supplementary proceedings. Of these some consist in preparing a synopsis or table of the compartments, in which the prominent elements, age, species, state of growth, &c., are exhibited. In this way the compartments are presented, so to speak, in a condensed form.

Others consist in aiding the mind by graphic representations or diagrams, the modes of preparing which are various; but the following will serve as an example:—

A horizontal line is drawn, divided into equal parts, each representing so many acres. On this base line rectangles are drawn. The base of each represents the area, and the height, the age of the growing stock. The top line of the rectangle is straight, or wavy; if the latter, it means that the stock is irregular; if the former, that it is regular. The rectangles are shaded with lines closer or further apart, which indicates that the stock is more or less close or sparse. A sign, in the shape $\wedge$, is used to denote the rate of growth. If rapid, the angle is made more acute; if slow, more obtuse. If there are large trees in the compartment, a vertical line is drawn, and two or three dots in this line show whether such trees are numerous or the reverse. It is customary to indicate differences of soil, and the prevalence of different species on the map, by aid of conventional colors.

This will be understood from the following figure:—



This figure shows at a glance, by the diagram method, the following state of compartments:—

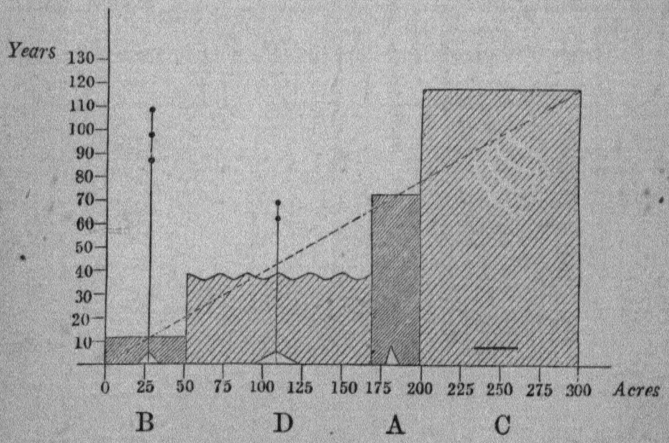
Rectangle A—Consists of 14 acres of grown poles passing into the state of young timber of 75 to 80 years old, very active growth ; stock dense and regular.

„ *B*—Consists of 24 acres saplings and thicket, regular, healthy; rate of growth, medium (neither very active nor slow) ; complete stock surmounted by a good many large trees. Mean age : 10 years for the general stock ; 90 to 110 years for the large trees.

„ *C*—41 acres high forest, exploitable at 120 to 130 years ; stock very open, and even containing some open glades ; growth, stationary ; on the whole the stock is even (or regular).

„ *D*—41 acres poles of 40 years, on the average mixed with stems younger or older, and with some trees of 70 to 75 years old. The stock is thus irregular and open : vegetation rather slow.

If we now rule lines, the base divided as before to show area and draw vertical lines also, showings ages, and a line across showing the ascending scale of ages, and then cut out little pieces of paper of the size of each rectangle, and arrange them on the scale so that the youngest may come first,—



we shall see that the material or capital is tolerably well constituted.

Comparing now this scale with the map of the forest, and seeing in what parts each area lies, we shall see if it is regularly disposed in such a way that a convenient order of compartment cuttings can be adopted in such a manner as to suit the rules of cultivation.

Such is the mechanism of the proceedings adopted. There are theories and practical rules regarding the formation of compartments which it is not the object of this little book to explain, as it does not aim at teaching how to make a working scheme, but in what such a proceeding consists.

I need only remark that in order to make a satisfactory "parcellaire" or division of the forest into compartments, aptitude and experience are as much necessary for the forester as they are for the farmer who studies the different varieties of soil in his farm so as to distribute advantageously the crops he will cultivate on its different parts.

In consequence of the inaccuracies referred to by Mr. Aplin on p. 210 of Vol. IX., "Indian Forester," the Translators of Puton's Aménagement des Forêts have carefully revised the 1st Part of that translation, and it is now issued as a Supplement to the April No. of Vol. X.